Chapter 14
Gender in Innovative Techno Fantasies

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Abstract Human beings are a symbolic species with a special capacity for fantasy. It has been argued by Terrence Deacon that the prefrontal cortex has developed alongside with language and tool-making and that this part of the brain is also connected with making plans (Deacon, 1997). This could mean that human agents have developed a particular capacity for creating their habitats according to their fantasies about how they would like to live in the future. However, this general argument does not allow for a deeper understanding of difference in human fantasies and how these differences might relate to gendered experiences. Human fantasies about future developments might differ with gendered human experiences. In feminist studies it has been a recurring theme whether we can argue for a gendered status of epistemic agency. In this article I shall inspect the claim of gendered epistemologies from the angle of gendered connectionism in relation to robotics and physics. The argument I want to make is that there might be no detectable difference in how female and male researchers envision scientific innovation, but there are differences in feminist and masculine techno fantasies and this might influence how we plan our future with technological tools.

To take off his filthy garments & clothe him with Imagination.
William Blake "Milton"

Science and technology are two interdependent realms of creativity which shape our futures in particular ways. In understanding the nature of scientific practice, feminists have asked 'whose knowledge' scientists are creating (Harding, 1991). They have answered by a harsh critique of what they have seen as a western, white male scientific rationality. Feminists have claimed that science and technology is basically developed by white, masculine fantasies, which by and large excludes marginalized people from non-western countries and women, while at the same time upholding an imaginary idea of a value-free, culture-free, objective scientific practice. Feminists furthermore claim that the masculine gender is inherent not only in how science is practiced, but also in how it is developed and how it is implemented in new technologies.

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Feminist epistemology has been engaged in this deconstruction of how masculinity has reconfigured science in its own picture of 'normal subjectivity', which is not (only) masculine, but 'phallogocentric' (nostalgia for the presence of the One true Word) (Haraway, 1991). Science will, in this perspective come to understand itself as being universal, rational and capable of transcendence through a denial of the importance of the body.

Would female epistemology open up for an entirely different approach to science than the masculinity approach? This is frequently discussed by feminist epistemologists – but just as often rejected partly because what is underlined is the situated nature of all subjectivities. The critique of the detached knower, which feminist epistemology share with the general community of Science and Technology studies (STS), has lead to an acknowledgement of *situated knowledges* (Haraway, 1991). This is the true feminist objectivity.

Scientists' agency matters in the creation of technologies. Scientists' engineers and their techno fantasies literally reconfigure our worlds through their inventions. In the words of the feminist physicist Karen Barad: 'Agency is not an attribute but the ongoing reconfigurings of the world' (Barad, 2003, p. 818). Often the new developments are invented and carried out by scientists in collaboration with engineers. Both of these fields have a lack of females researchers involved in the development and innovations of science and technology. It is however an open question whether more female scientists would make a difference in science.

If gender matters to physicists' agency and if it is a particular kind of fantasies guiding the agency of especially male scientists and engineers (e.g. science fiction inspired fantasies), it is no innocent claim. As science has been utopian and visionary from the start, the question is not only 'whose knowledge', but 'whose visions and techno fantasies' (Haraway, 1991, p. 186) will make up our future man-made worlds?

14.1 Emotional Human-Robot Interaction

One area where science and technology recently have contributed with innovation which almost certainly radically will change human interrelations is in the area of robotics. One of the salient examples of science fiction-like techno fantasies infiltrating with the real life of people is found in the so-called 'artificial emotional' robots already being put to use as devices to calm down senile people in old-age homes e.g. in Japan and Denmark.

Often these robotic techno fantasies of Human-Robot Interaction (HRI) have been created to solve problems, which have gender dimensions. In 2050 demographics show that one third of the population in Japan will be over 65. In Denmark the picture is more or less the same. In both countries it is traditionally the role of women to look after elderly people, and there is no doubt that the increasingly aging population will put a pressure on the demand for old-age home workers. This can lead to a demand for a more educated workforce, who can drive innovation and develop innovative new thinking on-the-spot.

Another solution has been suggested from robot scientists: create robots which can take some of the pressure from the demanding tasks done by the primarily female old homes staff. One such robotic invention is Paro, a creature of aluminium, nuts and bolts covered with soft, white, antibacterial fur formed in the shape of a baby harp seal and with huge dark eyes. Paro was originally designed in 1993 by a male scientist, Takanori Shibata, from Intelligent Systems Research Institute at the National Institute of Advanced Industrial Science and Technology (AIST) in Japan. The creature weighs three kilo and is designed to create emotions in old people through physical interaction. It has inbuilt tactile sensors and adaptors, which makes it possible for the seal to 'learn' from human contact and it can react to touch, sound etc. In clinical tests it has been shown to relax and comfort elderly senile people and even increase their brain activity. In a small study of the effect Paro had on elderly people the robot apparently made old people more communicative than usual and even showed effects on dementia (Wada, Shibata, Saito, & Tanie, 2004; Tamura et al., 2004, p. 609).

It has already been tested and put to use in a number of old peoples homes in Denmark, where it apparently stands out as a huge success.

At for example the old people's home, Bakkeager, in the municipality of Vejle, Paro was met with enthusiam. The home has 50 inhabitants from the age 66–100 years and 75 % of the old people are senile.

It is underlined by the manager that Paro is not a substitute for human contact with the staff, but should be seen as a supplement. The staff follows courses where they are certified in the use of Paro, so they can make professional use of the robot in their daily work. Employees at old peoples' homes thus learn how to deal with the innovative device developed in Japan rather than develop innovative solutions themselves. One area where Paro can help the staff is when conflicts arise at the centre. Here Paro can be used as a 'diversion'. On a homepage connected to the old-age home it is described in these words: 'The lively and affectionate baby seal has proven to have a positive and stimulating effect on the people with senile dementia. It awakens positive sentiments, curbs aggressive behaviour and can in some cases increase brain activity in the residents with senile dementia.'[1]

Could a female scientist have developed a similar creature? Would the predominantly female staff have imagined this solution to their everyday problems themselves? Is Paro the result of a particularly male scientists' techno fantasy or are new assistive robot technologies a sign, that women bring experiences from health care environments to the sciences and are opening for a new development of assistive technologies building on women's fantasies?

[1] www.teknologisk.dk/paro

14.2 Lack of Female Scientists

There are three arguments for why women generally could be expected to drive the development of techno fantasies in science to a lesser degree than their male colleagues:

1. Women's' work receive less acknowledgement than males in natural science and engineering and often they do not receive full credit for their contributions or support for development of their ideas.
2. Women in general care less about developments in science and technology than men. They prefer to study human subjects, such as psychology and languages, and are underrepresented in studies of science and engineering.
3. Women who set out on a career path in science and engineering are to a comparatively easier pushed out through subtle cultural mechanism than their male colleagues and thus excluded from developing science education and practice.

It is well documented, that female scientists are not receiving the same attention and support and that their work in science and engineering is considered less important than the work of their male colleagues – even when they were working side by side. The place of women in science has been in the margins. This has been documented in close-up studies of women's possible career paths within a wide array of scientific fields such as biology (e.g. Haraway, 1989; Keller, 1983), engineers (e.g. Meilwee & Robinson, 1992), physics (e.g. Schiebinger, 1989; Keller, 1977; Wertheim, 1995), mathematicians (e.g. Henrion, 1997). It has even been argued, that the few women entering a career in science, try to hide their womanhood (Schiebinger, 1989) and deny the experiences and preferences of being female. Even though women have entered the sciences in increasing numbers at student level the dismal picture has not changed much over the past thirty years (Chimba & Kitzinger, 2010).

The lack of women in science and engineering has increasingly been enunciated by politicians as a problem in line with universities having turned into 'mass universities' – not least due to a massive intake of female students. Higher education in science and engineering have not benefitted from the development. Women have chosen to study human subjects such as psychology, design, anthropology and other areas which involve human factors. Girls already in secondary school deselect science issues and show much less motivation than boys for learning scientific and technological subjects (Sjöberg & Schreiner, 2005). This has led to discussions of whether the diversity in interests mirrors basic differences between boys and girls (Stadler, Duit, & Benke, 2000). The lack of women in science and engineering has also been documented statistically in a number of studies, Osborn et al. (2000), Bebbington and Glover (2000), Rees (2002), European Commission (2009).

The same studies show that women enrolling in science and engineer studies do not advance to the same degree as their male colleagues. Even though we find cultural differences (Barinaga, 1994; Rees, 2002; Hasse & Trentemøller, 2008) it is a general trend in all countries that women do not advance in science and engineering to the same extent as their male counterpart – no matter how equal their numbers are when enrolling in higher education to study science or engineering (TERSTI, 2003, p. 263; Osborn et al., 2000). One explanation for this leaking from science careers (Alper, 1993) or rather the free choice of not wishing for at career in science (Svinth, 2008) has been argued to be tied to a male dominated research environment which through subtle everyday exclusion mechanisms exclude women from advancing in their careers and eventually make them want to leave (Hasse & Trentemøller, 2008). There is a certain 'policing' of the borders of science (Rouse, 1991) which seems to exclude women. But women also in their own right deselect natural science and engineering at an early stage in their educational patterns and prefer other kinds of more humanistic oriented studies. (e.g. Etzkowitz, Kemelgor, & Uzzi, 2000). As a new trend women enrol in technological and scientific studies when they have been connected to softer skills than just mechanical and technical skills – for example new combinations of design and engineering. All though this cultural pattern of in- and exclusion is not directly linked to knowledge production, male and female scientists might work from different gendered experiences which are more or less acknowledged by the scientific community and in the end also affect the scientific knowledge itself (Hasse & Trentemøller, 2008). Would science change if more women held top-positions in science and women's experiences were allowed to influence the creation of what was considered valuable scientific knowledge and technological innovations? Would we see fewer or more robots like Paro? Do women prefer science with a more humanistic aspect to it?

The answer to the latter question is a cautious 'yes': not only do we find more women in the humanities than in natural science (European Commission, 2009); within natural science many women prefer to work in areas with direct implications for human beings like e.g. in medical physics rather than in the more 'aloof' areas of theoretical physics (Hasse, Trentemøller, & Sinding, 2008, pp. 150–153). And an even more cautious 'yes' to the first question: maybe science would change if more women had science careers. But does that necessarily mean that gender *matters* in scientific re-configuration of our common world? I shall argue, though more research is needed to make the argument stronger, that we would see more emotional robots like Paro if more women entered science. Not because they are women, but because the new type of emotional robots represent a turn to soft skills more connectable to many women's experiences – skills which are also increasingly shared by men.

The development of emotional robots can be seen as a post-Fordist development, which has come to trump hard skills. Hard skills were during the Industrial Revolution and through the Fordist era, associated with manual and mechanical operations and led to scientists and engineers development of industrial robots. Soft skills are conceptualized as being parts of ones self such as social sensitivity, emotionality and modes of thinking, communication and conflict handling social skills – and it is these capacities which today are wanted, even dictated by an inventory of national, social, and market needs (Urciuoli, 2008). These skills have been the ones sought-after in the typical woman occupations – such as the staff at old people's homes.[2] Making robots like Paro illustrates the change from a focus on hard skills in the Industrial society coupled with a focus on hard technology towards a new soft skill society dominated by values traditionally and stereotypically ascribed to womanhood.

14.3 From Sci-Fiction to Sci-Facts

Industrial robots are an integrated aspect of human worklife today as well as occupy an important position in the science fiction fantasies of tomorrow consumed (and sometimes also written) by male physicists and engineers. Physicists and engineers share a passion for what has been called ‘hard science fiction’. Science fiction motivates many physicist students to study physics – but mainly the male students. Even though there is no clear connection between the actual doings of science, technology and science fiction many possible links have been documented.

In my own work as an anthropologist at the Niels Bohr Institute I enrolled as a first year student of physics with the aim of studying gender in relation to what could be analysed as a cultural world of physics as seen from a position of a newcomer (a woman and anthropologist – with all the problems and possibilities following from these positions). More specifically I studied how newcomers became old-timers (Lave & Wenger, 1991) through processes of embodied learning connections between systems of meaning and physical objects (Hasse, 2008a, 2008b). This is in line with the feminist methodology in science studies. ‘If natural sciences and their preoccupations in reporting on nature are embedded in and complicituos with social projects, then a causal, scientific grasp of nature and how to study it must be embedded in – be a special area of – causal, scientific studies of social relations and how to study them’ (Harding, 1991, p. ix).

As also noted by the anthropologist Mary Douglas, inspired by Ludwig Fleck, science is fundamentally a ‘thought world’ (Douglas, 1987). To come to know this thought world you must engage in the everyday practice, which opens up your own phenomenological learning process (Hasse, 2008a, 2008b). This is not least true if you want to learn about the fantasy and imaginaries connected to the thought world. Anthropologists have formerly studied apparently more exotic ‘imagined thought worlds’ than the what can be found at the Niels Bohr Institute. Even so I was also in the apparently familiar environment introduced to strange traditions and behaviours. I agree with one of the founding fathers of interpretative anthropology, Clifford Geertz, when he states that: ‘Anthropology is only apparently the study of customs, beliefs, or institutions. Fundamentally it is the study of thought’ (Geertz, 1973, p. 352). It is, however, also a study of materiality and the entanglement between thoughts (and fantasies) and physical objects and spaces.

[2] It is a general trend in Western Countries that labour markets are gender segregated and that women take jobs in areas connected with care and soft skills. See e.g. International Labour Organization, http://www.ilo.org.

In my study I used the method of participant observation and took it literally that participation in everyday activities of all kinds is the road to learning (Lave, 1997) also in educational institutions (Billett, 2004). I followed introductory courses in physics, math, astronomy and I also followed the students in other everyday activities connected to physics study. I went to FREBAR (Friday Bar hang-out-time), parties, and participated in the yearly student theatre show 'Fysikrevy'. What I learned was that, in addition to what others have had to say about learning physics as a thought world – most notably the science historian Thomas Kuhn (1977) – this thought world consisted of much more than learning symbolic reading of nature through learning equations combined with learning an arsenal of 'best exemplars' and other elements of a disciplinary matrix in classes such as these on the class schema.

In the study of thought worlds what matters for anthropology is to bring 'connections to light' to quote another anthropologist Marc Augé (1999). Following a cultural-historical approach these connections can be perceived as connections between meaning-systems and materiality (Cole, 1996), but we could add to this the connection between manifest expressions of fantasies of the future (e.g. in books, movies and talk) and dreams of how to make this future come true. This is what I have elsewhere termed the 'relational zone of proximal development' of physics (Hasse, 2001). What became the biggest surprise for me learning among the physicists students were the new unexpected connection I learned to make between the scientific 'core' of textbook physics and a lot of seemingly extracurricular and therefore seemingly unconnected other fantastic aspects of a physicist students everyday life (Hasse, 2008a).

In my further analysis one aspect stood out: the frequent reference to science fiction (primarily among the students). It was a surprise that although male students actively engaged in conversations about the connections between science fiction and physics – almost no women participated neither in everyday conversations, nor in the 'Fysikrevy' where these issues were treated in an ironic fashion by the students themselves. In this particular thought world I learned that material objects like magazines on humanistic subjects were 'out' and science fiction literature was 'in'. In the institutional cultural logic reading science fiction was considered a serious occupation because it contained the seeds of tomorrow's future physics. Old timers among the students discussed science fiction literature, and science fiction related subjects openly. Discussions in the student room and other places often brought in science fiction topics like 'warp speed', antimatter as propellant fuel, space creatures and cultures like 'the Klingons'. Through science fiction discussions the students formed questions that are also important for part of physics science today: is there life in space? Is travel to other solar systems possible? The students would take as a point of departure for questions of time and curving space the episode of 'Starwars' where the pilot Han Solo makes his starship 'Millenium Falcon' speed up. From this point of departure they would discuss how it would be possible to develop what in the movies are called hyperdrive propulsion system that propel a starship through an alternate dimension of hyperspace and thereby make travel between star systems possible. They would also ridicule Han Solo for saying that his space ship is '[t]he one that made the Kessel run in [x] parsecs!' because parsecs are a measure of distance, not of time. But they did not question the extremely stereotyped presentations of gender and the almost primitive psychological landscape in these visions.[3]

In a survey among the newcomer students I asked about their reasons for enrolling in the physics studies. Among 14 possible answers only two other reasons for enrolling got higher scores than 'science fiction as contributory cause'. Almost one third of the male students, 32%, and 7% of the female students, gave this explanation for their motivation to study physics, which made it the third most popular answer only surpassed by 'Reading books on great physics theories' and 'Engaged teaching in physics in high school' (Hasse, 1998, pp. 16–18).

Others have noticed the connection between the development of science and hard science fiction as an inspirational source for the physicists-to-be. Hard science fiction is technically oriented and in physics it is fictions like W.C. Well's time machines, Arthur C. Clark's universe, the Star Wars movies and the television series Star Trek which have received the most response from physicists (e.g. Nahin, 1993; Krauss & Hawking, 1996, Kaku, 1994). At the annual American Association for the Advancement of Science (AAAS) hard science fiction has also been discussed and Leroy Dubeck has presented his theory on learning science through science fiction building on the book Fantastic Voyages: Learning Science through Science Fiction Films. And several American universities have advertised courses with titles like 'The Physics of Star Trek' and 'Cosmology: Science Fact to Science Fiction' (see e.g. Dubeck, Moshier, Bruce, & Boss, 1993). Hard science fiction is even sometimes explicitly 'helping science' to get ideas as when science fictions writers are invited to help envision the future paths of science.[4] Many natural scientists have also turned into writers of science fiction novels. Science fiction is connected to gender in so far hard science fiction is connected with male science fiction writers, whereas soft science fiction – which includes fantasies of transformed bodies and social skills – has more female writers. Gender is also connected to science fiction in general as this genre as a whole is connected to maleness. Boys and science fiction are for example often connected in literature on science learning, and science fiction is used for learning purposes to spur boys' interests for science as well as reading (Lie, Linnakylä, & Roe, 2003, p. 52)

[3] The gendered stereotypes in science fiction can also be found in robotics – see for example the many chatterbots presented as 'sexy women' (like Amythechatterbot) or the Starfleet officer Captain Kirk from Star Trek.

[4] (One example of these encounters took place in 2001 when science fiction novelist Ben Bova was an invited speaker at NASA's 'Turning Goals into Reality' conference on aerospace transportation in May 18–19). http://tgir.msfc.nasa.gov

14.4 From Hard Science to Female Fantasies?

On the one hand science has generally proven to be hostile to the claims of imagination in science (Daston, 1998). Science has been argued to have an internalist self-understanding resting on the central assumption that the success of science is insured by its internal features (Harding, 1998, p. 2). Science sees itself as being 'outside of culture' and can in the internalist self-understanding be perceived as an objective scientific endeavour whose practitioners develop science through hard work and natural skills and where 'temperament, gender, nationalism or other sources of disorder' are of secondary importance (Traweek, 1988, p. 162).

Feminist epistemologies cover a number of diverse themes countering this perspective using gender as en eye-opener for new kinds of epistemic analysis. Many feminist studies of science and technology have demonstrated that scientific practices build on what we with Helen Verran can call 'ontic-epistemic fantasies' connected to the specific co-configuring practice which connects engagement, metaphors and visions with our daily interactions with the material world (Verran, 1998). Verran names these fantasies and tropes 'imaginaries' – specific fantasies tied up with knowledge systems, which have been simultaneously used and denied in the western world (ibid., 250).

Scientific knowledge is in the feminist and STS-perspective 'location, partial embodiment and partial perspective' (Haraway, 1991, p. 191). In feminist science studies the situated nature of knowledge has consequences. When science is considered a human, embodied and material practice (Haraway, 1991, 1988), boundaries between subjects and objects are never fixed and observation of scientific objects is also a practice. Therefore science needs to accept the value of multiple perspectives on how to construct science to ensure values and taken-for-granted criteria of scientific practices to be called into question (Longino, 1990). Sandra Harding even claim that

> [a]dequate social studies of the sciences turn out to be the necessary foundations upon which more comprehensive and less distorted descriptions and explanations of nature can be built (Harding, 1991, p. 15).

Feminist science studies is not denying some kind of reality but it is a reality bound to be, in the words of Barad, an 'agential realism' (1999) including materiality and specific situated, and never abstractable, knowers as agents. The agential realist framework changes the question from how discourse comes to matter to how matter comes to matter (Barad, 1998, pp. 89–90).

Gender is not shut out of these processes. Gender is rather emerging when performed in the everyday practice of science. Or in the words of the physicist and feminist Barad in our 'intra-actions', which create mattering matter and gender as well. Barad (1998, p. 108) describes the process as: '(M)aterialization is an iteratively intra-active process whereby material-discursive bodies are sedimented out of the intra-action of multiple material-discursive apparatuses through which these phenomena (bodies) becomes intelligible'. Gender is not something we have or are in a biological sense, but something we do (Fenstermaker & West, 2002, Butler, 1990). This approach dissolves the stereotypical notions of culture and gender found in mainstream science fiction. If scientific 'doing' involves reading fiction we have to consider how it can 'be the opportunity for the individual's imagination and memory to experience the existence of other imaginations and other imaginary worlds' (Augé, 1999, p. 99).

For many the idea of robots like Paro is an important step towards the humanoid robot worlds depicted in science fiction literature. Paro is not alone out there either. In Denmark cleaning robots is already a natural part of everyday life in public institutions and private homes. They might, like Paro, be made of aluminum, bolts and nuts but they have anthropoid names like 'Skupido' and 'Roberto'. Techno fantasies at Japan's University of Tsukuba has reportedly also created robots like the 2009-launch of the baby-robot Yotaro, a baby simulator which train parents to deal with babies shedding robotic tears before they give birth to their own child. Robots of this kind have one thing in common. What is special about this new type of robotics creating Paro and other artificial emotional robots is, that they are designed to do tasks which have traditionally primarily been done by women.

Is the future of science and technology shaped through a phallogocentric and masculine thought world feeding on science fiction fantasies, dreaming about a world where female soft skills workers are replaced by robots?[5]

The empirical material can, when combined, can be argued to support a thesis of techno fantasies connected to gendered embodiment and experiences (which again could be related to the argument put forward by Theresa Schilhab) (Chapter 12, this volume). This is, from the perspective of a feminist epistemology, not necessarily the same as an argument for a gendered epistemology based on biological difference.

14.5 Female or Feminist Epistemologies

In the natural sciences there has for long been a struggle for trying to get more women to become physicists. Not to improve or change science, but because it is seen as unjust that women do not have the same opportunities as men. The idea that this should make physics become more feminist has been seen, by male and female physicists alike, as a kind of heresy (Auchincloss, 1998). Gender has been seen as neutral in relation to how science develops.

Most feminists have countered the claim that science is gender neutral. In the book Reflections on Gender and Science Evelyn Fox Keller argued for the link between masculinity, notions of objectivity and the exclusion of women from the development of science (Keller, 1985). Rosi Braidotti and her colleagues and Sandra Harding have discussed the relation between the first-world scientific agenda, excluding local knowledge traditions and gender (in relation to protection of the environment vs. Exploitation) (Braidotti, Lazaroms, & Vonk, 2001; Harding, 1998).

[5] In South Korea BBC News could recently report, that a "Robot Ethics Charter" has been drawn which discuss the rights of robots versus people.

Many studies have shown how sex and gender have been culturally constructed from a masculinity perspective in biology and how culture in general provide science with perspective, metaphors and stereotypes reproduced and reinforced by scientific practices and results (e.g. Daston & Park, 1998; Hird, 2002; Franklin, 1995). It has even been argued that there is a possibility for masculinity to influence even the most objective sciences such as physics (Rolin, 2001) and that physics is embedded in national cultures and their respective more or less masculine dominated gender patterns (Traweek, 1988; Hasse & Trentemøller, 2008).

Some have insisted that *women* for example would focus less on 'explosions' and solid matter and more on bodies and fluids (e.g. Bleier, 1984; Irigaray, 1985) thereby placing a direct link between biological sex and scientific research preferences. So far there has not been much serious research connected to this claim – and it is often rejected by female scientists themselves (e.g. Stengers, 1997, 2000) as well as feminists who see it as a return to an essentialist point of view (Wajcman, 1991). In a feminist epistemology it is pointed out those notions of fixed biologically determined 'sex' is as 'situated' as knowledge (Haraway, 1989). Therefore a feminist epistemology does not in general support the idea of biologically fixed gender differences.

In most of the feminists studies of today we find the notion that biological sex as well as gendered performances are constructed along side with the construction of the phallogocentric 'view from nowhere' (Haraway, 1991) approach. Donna Haraway has attacked biological determinism by showing how constructions of the female sex in biological research are inherently cultural and historical (1989).

The gendered body is never fixed and bounded in stereotypes, but is a process of reconfigurations, which might seem as bounded and fixed, but which in reality is moving when we are.

> [O]f materialization that stabilizes over time to produce the effect of boundary, fixity, and surface we call matter. . .Crucially, then, [the construction of bodies] is neither a single act nor a causal process initiated by a subject and culminating in a set of fixed effects (Butler, 1993, pp. 9–10).

It seems therefore problematic to claim that a science governed by *women* should be more carried by different scientific techno fantasies than science made by men and that these biologically fixed categories of gender is what produces differences in techno fantasies.

14.6 Female Techno Fantasies

It should come as no surprise from this feminist perspective that one of the worlds leading robot developers is a woman Cynthia. The work of her research group at MIT was named one of the 50 Best Innovations of 2008 by TIME magazine. Her special approach is to build soft skills such as sociability and capacities for learning into robots.

> Social (or sociable) robots are designed to interact with people in a natural, interpersonal manner – often to achieve social-emotional goals in diverse applications such as education, health, quality of life, entertainment, communication, and collaboration. The long-term goal of creating social robots that are competent and capable partners for people is quite a challenging task. They will need to be able to communicate naturally with people using both verbal and nonverbal signals. They will need to engage us not only on a cognitive level, but on an emotional level as well. They will need a wide range of social-cognitive skills and a theory of other minds to understand human behavior, and to be intuitively understood by people. A deep understanding of human intelligence and behavior across multiple dimensions (i.e., cognitive, affective, physical, social, etc.) is necessary in order to design robots that can successfully play a beneficial role in the daily lives of people. This requires a multidisciplinary approach where the design of social robot technologies and methodologies are informed by robotics, artificial intelligence, psychology, neuroscience, human factors, design, anthropology, and more. (Breazeal,Takanishi, & Kobayashi, 2008).

In taking this approach to robot design Breazeal integrates particular branches of humanistic sciences which have for long been dominated by women. She is, like the feminists, breaking stereotypes of how natural and human sciences should be kept apart. But she is also reproducing the stereotype of women connected with soft skills interests.

In most universities in the western world women constitute the majority in the humanistic studies, whereas male students dominate in the natural sciences (European Commission, 2009). Even within the narrow discipline of physics many women seek more down-to-earth subjects like geophysics and physics used for developing hospital equipment rather than theoretical physics (Hasse, and Trentemøller, 2008, p. 213).

Like Paro the robots created by Breazeal (e.g. Cog and Kismet, Huggable) are ‘artificial emotional’ robots which open up for a new understanding of what robots can be used for. Instead of the focus on technical and mechanical robots prevalent in the Fordist era, these post-Fordist robots focus on the soft skills. That these skills primarily were understood as connected with being female might be what is really the major paradigmatic change in science as well as society.

As noted by Lucy Suchman the dream of machines (and the robotic visions connected to it) as the new servant class have been changing from the industrial age to the age of the service economy. We find this vision presented and discussed in many critical feminist contributions – most notably by Suchman herself (e.g. Suchman, 2007).

Paradoxically lots of funding has been given to make it possible for the scientists in natural science and to developers of technology to reconfigure our material worlds with robots whereas the question of whether gender matters for the actual development of scientific endeavours remain under researched. Very little empirical work has been invested in looking into the obvious diversity on male and female access to influence scientific reconfigurations – and how these reconfigurations are connected to techno fantasies. From the argument presented above we should not look for biological sex for answers. Feminism has changed science (Schiebinger, 1999; Alcoff & Potter, 1993), because we from this perspectives can ask new political questions on how situated human beings, with partial perspectives (Strathern,

1991) create each others worlds. 'Feminist research orients us not only to relations and symmetries among persons and things, but also to the politics of difference' (Suchman, 2005, p. 6).

14.7 Cultured Bodies?

Feminist epistemologies on the one hand criticise masculine scientific techno fantasies, but deny they are connected to the sexed body. Different politics of science fantasies might be embodied, but bodies are not fixed gendered stereotypical entities. When feminist epistemology stress the situatedness of knowledge – including bodily situatedness (Haraway, 1991) they come close to other STS theories which also acknowledge the importance of embodied experiences in science. Postphenomenology for example also oppose the 'classical' notion of epistemology where the identity of the knowing subject is not important. In this move from decontextualised to situated knowledge both post phenomenology and feminist theory reject knowledge understood as decontextualized and stable. Knowledge is situated knowing in action. The postphenomenological understanding of perception/knowledge as it appears in the work of Don Ihde operates with an analytical distinction of the body into two:

> Body one: Micro-perception (bodily-sensory dimensions)
> Body two: Macro-perception (cultural-hermeneutic dimensions) (Ihde, 1993, p. 74).

Culture is in this perspective not a superficial layer placed as a circle outside an equally encircled individual. Agent and culture are intertwined in a manner which makes it senseless to speak of where the body begins and the culture stop. Sense, emotion and culture form each other.

In cultural-historical theory we find the same assumption, which has led to many studies of how cultural learning processes form our self-evident understandings of how to engage with the world, which is never separate from us but emerge as we interact (Hasse, 2008a, 2008b). Not least the practice-based approach by Jean Lave and Etienne Wenger (1991), Yrjö Engeström (1987) and Michael Cole (1996) have thought us that knowledge is embedded in materiality, materializes historically and culturally and is situated in relations. We might even speak of a cultural epistemology which makes us understand numbers in culturally informed ways (e.g. Verran, 1998). Gendered epistemology can also be argued to be cultured as cultural diversity is formed in gendered embodied experiences. Also scientists embodied experiences are mattering matter.

In some arguments it has been argued that being a *woman* gave access to different life experiences and thus different morals, senses of self (Gilligan, 1982). In the cultural-historical perspective experiences are in a pragmatic and post phenomenological way more than just senses, but the whole of the body engaging with the surrounding world (Ihde, 2002). It is not about being a stereotype (woman), but about the cultural-historical changing possibilities for engaging with the world.

Cultural embodied knowledge is thus to be understood as embedded in subjects. The learning body might stabilize over time to produce the effect of some kind of boundary. The boundary formed by ongoing experiences is the gendered epistemology building on the politics of difference. This is normally taken for granted, but feminist epistemology has opened our eyes for how differences, also in techno fantasies in science and the values they propose, are culturally created and installed in bodies. Therefore it is likely to the point when Harding is ascertaining that

> [s]ocial values cannot remain undetected in studies of the abstract laws that govern the movements of the physical universe. It is far more likely the researchers import their social values into studies of other humans than into the study of stars, rocks, rats, or trees. (Harding, 1991, p. 79).

14.8 Towards a New Vision of Science

Paro and the emotional robots may not be the materialized results of male techno fantasies. They rather point to a change in techno fantasies in general. If science is changing it is likely because science is entangled in an emerging Post-Fordist soft skill society. We see changes in the increasing number of women in science, the increasing number of students studying humanistic subjects as well as in the artificial-emotional robot designs in particular. In the new politics of difference new scientific fantasies might appear and they might challenge what we have considered to be innovative in the past. Technological inventions have in a naturalized way guided scientific fantasies.

All cognitive functions including thinking in mataphors and symbols can be argued to be tied to fantasy (Raudla, 2008). In relation to the arguments put forth by Terrence Deacon in *The Symbolic Species*, it could be argued that humans can change their environment through symbolic means and that this process is somehow connected with human fantasies. Humans can, in other words, fantasise about future technologies which can act as tools to change their habitat. The science fiction books and movies I encountered at the Niels Bohr Institute did, I shall argue, just that. Fantasies act as directional forces on physicists and engineers constructions of mattering matter, which in subtle ways led scientific endeavours forward towards changes in the human habitat inspired by the fictional Star War or Star Trek societies.[6] But will these kinds of fantasies also in the future be our source of inspiration? Here a new interesting discussion about how symbolic meaning of technological tools change over time is opened up. What is *considered* innovative fantasies might be relational and tied to the diversity of human gendered experiences. With the words of Suchman:

[6] Even Breazeal has told reporters that she was inspired by science fiction and not least the Star War series.

> We need to ask how projects to reclaim
> creativity, invention and the like might themselves be reproductive of a, specific, cultural and historical preoccupation with these particular values. Must those not presently identified as creative be shown in fact to be inventors in order to be fully recognized? This question suggests that we need to pay close attention to the tensions and contradictions that arises when we adopt a strategy that distributes practices previously identified exclusively with certain people and places (for example, with privileged white men working in elite institutions of science and technology) across a wider landscape (one thatincludes women). (Suchman, 2005, p. 2).

The political reason for giving female perspectives more space in science is not that they are women but that women may be carriers of different embodied experiences in body one as well as body two and that these experiences might point to the development of a more human and less humanoid robot vision of our future. Many women have a passion for reading literature very different from the stereotypical one praised in science fiction circles. What Susan Star and Lee Bowker questions in informatics might concern science in general:

'Why should computer scientists read African-American poets? What does information science have to do with race-critical or feminist methods and metaphysics? The collective wisdom in those domains is one of the richest places from which to understand these core problems in information systems design: how to preserve the integrity of information without a priori standardization and its often attendant violence? In turn, if those lessons can be taken seriously within the emerging cyber world, there may yet be a chance to strengthen its democratic ethical aspects. It is easy to be ethnocentric in virtual space; more difficult to avoid stereotypes. The lessons of those who have lived with such stereotypes are important, perhaps now more than ever' (Bowker & Star, 1999, p. 302).

Would science develop differently if it was practiced by other kinds of people, who for example have experienced the stereotypes of being women or black on their own bodies? Will new symbols be created which can feed in to new fantasies acting as directional forces on what tools to use and how humans should construct their habitas? If science can be said to be limited in its scope by such stereotypes how do they connect to the development of science? If personal experiences, like reading poetry, might open up for new spaces of scientific inquiry – what kind of driving forces develop science today? And are these present driving forces inherently connected to male experiences? These questions are not just relevant from a feminist point of view, but concern the very nature of scientific knowledge and its development. When society move to value other kinds of soft skill experiences we might find conflicts – not between industrial robots being outnumbered by artificial emotional robots but a war between techno fantasies and poetic fantasies.

In our contemporary world our problems develop when images build upon images and when images are lost. This is 'the risk that we run today with the war of dreams' (Augé, 1999, p. 56).

A counter project is to question the very force with which techno fantasies are supported in society and the way innovation itself is understood as tied up with technology. The moral and political aspects of science (Haraway, 1991; Alcoff, 1996) also concerns what kind of embodied experiences can develop science. Access of the marginalized to scientific practices will change the kind of questions asked in science and thus the scientific endeavour as such (Hartsock, 1989, Harding, 1991, 1998). Maybe soft skills in the future politics of science will be connected (by male and female scientists alike) to more poetic versions of the future than innovations build into robots of aluminium and antibacterial fur. Maybe the innovation should concern the staff at old people's homes together with the old people and their possibilities to invent and create new fantasies not already embedded in ready-to-use technologies. Feminism directs our attention to the importance of 'the human aspect' of science and towards research in our basic lack of understanding of how culturally formed fantasies and dreams can be built into technologies shaping our lives.

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